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SOME IMPACTS OF SPRUCE'S AMAZON EXPLORATIONS ON MODERN PHYTOCHEMICAL RESEARCH*

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It was on July 12, 1849 that one of the most extraordinary feats of botanical exploration in South America began. For, on that day, Richard Spruce arrived at Belém do Pará to start his epoch-making phytogeographic studies and collections in the Amazon Valley and the northern Andes from 1849 to 1864 (15, 23).

Undoubtedly one of the greatest explorers of all times, his name is known today to a mere handful of people whose interests in botany and travel have inevitably brought them face to face with the life and work of this great man.

Richard Spruce was born in the tiny hamlet of Ganthrope, a few miles from Malton, Yorkshire, on September 10, 1817, and died seventy-six years later in the neighboring hamlet of Coneystrope, on December 28, 1893. The simplicity of his life is admirably brought out by this one fact: having travelled for fourteen years the wildest of areas — some so inaccessible that only now, after the passage of one hundred years, are scientists again penetrating them — Spruce returned, not to London or permanently to any of the great botanical centres of Britain, but to a little cottage in his native countryside. For it was his childhood rambles in this fascinating countryside that had fostered

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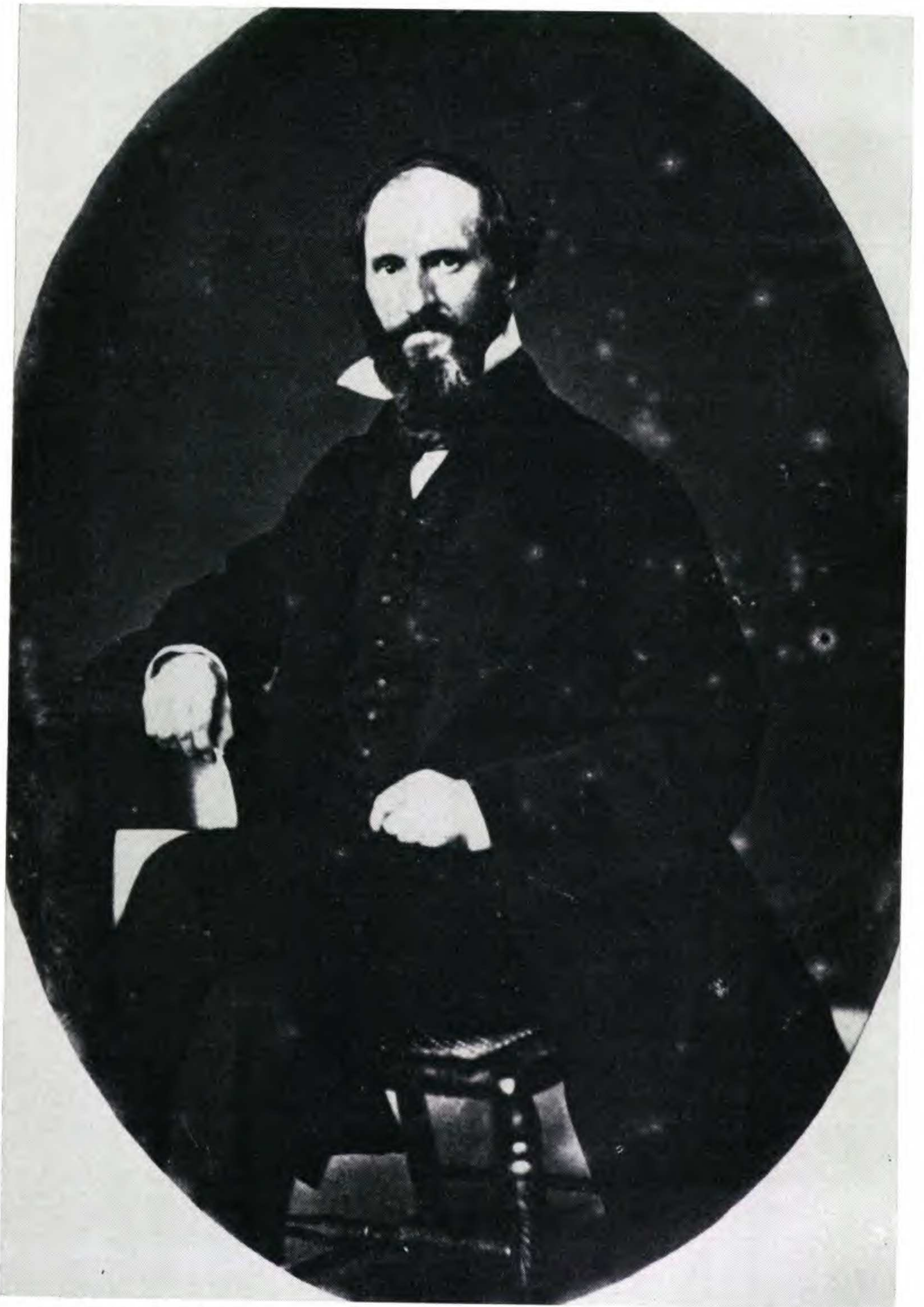


Plate 1384. A photograph of Richard Spruce taken after his return to England from his South American expeditions. Original in the Gray Herbarium of Harvard University.

his love and knowledge of botany which developed at such an early period of his life that, in his sixteenth year, he had compiled a list of 403 species of plants of Ganthrope, followed, several years later, by a List of the Flora of the Malton District, enumerating 485 species. It was during this period that he became deeply absorbed in mosses and liverworts, "the joy of his early manhood and the consolation of his declining years," groups of plants in which he became an investigator whose authority will stand as long as men delve into the natural history of the bryophytes.

In Spruce, we find perhaps the greatest contrasts ever known in a botanist. A man of extremely delicate health and plagued by chronic ills, he betook himself to one of the wildest and least known jungle areas of the world, to spend fourteen years of his life in hard physical work, constant exposure to the tropical elements and diseases, insufficient diet, and complete lack of even rudimentary comforts. A scholar with a thorough classical training and of outstanding cultural and scientific attainments, he divorced himself from all centres of culture and lived for long periods amongst Indians or unlettered half-breeds. A superb correspondent, he plunged himself into regions where, for months on end, he received not one letter or newspaper. A botanist whose training and first love concerned mosses and hepatics — the most diminutive of land plants — he carried out painstaking research on some of the most gigantic of tropical trees and lianas, even discovering hundreds which had hitherto been unknown to science. A poor man, he contributed through his work on the quinine-tree in Ecuador, to the creation of great plantations and fortunes, which resulted from the domestication of this plant in the British possessions of the Far East. A mild-mannered and dignified person, he feared none of the dangers that his expeditions presented, and more than once had to take measures to defend his very life. A student whose scientific training had fitted him to handle masses of minute detail, he was able to cope with the endless problems attendant on the organisation and execution

of cumbersome trips by canoe or on horseback of months' or even years' duration. And, perhaps most astonishing of all: a naturalist who looked with abhorrence on the philosophy that nothing not immediately beneficial to man was worthy of study, he nevertheless provided science with the first extensive botanical knowledge of *Hevea* rubber (which was just then beginning to attract extensive commercial attention), made far-reaching practical researches on the quinine-tree and filled his note-books with observations and studies on all manner of native economic plants, including gums and resins, fibres, foods, drugs, narcotics and stimulants, oils, dyes, and timbers.

But what has this mild-mannered botanical explorer of a century ago to do with a modern phytochemical survey of the Amazon? When answering this question, we might find it somewhat paradoxical to read from one of Spruce's letters the following philosophy. Speaking of his special group, the liverworts, he wrote: "I like to look upon plants as sentient beings, which live and enjoy their lives — . . . when they are beaten to pulp or powder in the apothecary's mortar, they lose most of their interest for me. It is true that the *Hepaticae* have hardly as yet yielded any substance to man capable of stupefying him or of forcing his stomach to empty its contents, nor are they good for food; but if man cannot torture them to his uses or abuses, they are infinitely useful where God has placed them, as I hope to live to show; and they are, at the least, useful to and beautiful in themselves — surely the primary motive for every individual existence." Are these, you may justifiably ask, sentiments conducive to research into drug plants? Strangely enough, I would answer you a very definite *yes*, for they bespeak the deepest love for plants which, after all, must underlie any success in our search for promising new physiologically active substances through ethnobotany.

Spruce lived closely with the native Amazonian peoples, seldom interrupting his stay with trips to urban centres. He learned several of their languages. He had an ever inquisitive mind and a most perceptive botanical eye. For

a number of plants that have later attracted extensive phytochemical and medical attention — and which are still claiming serious study — it was Spruce who gave us detailed, accurate and pioneer information.

A very thorough study of this field information might serve modern phytochemistry well in orienting the search for new physiologically active plants or in investigating more deeply and critically those which we do know. In this discussion, I have chosen to speak about Richard Spruce, but I might have talked about any of a dozen of the earlier botanical explorers of tropical America. Most of them — Humboldt, Schomburgk, Martius and others — are repositories of such information, in great part neglected or not fully exploited by the modern phytochemist. Do I dare to hope that the following words will help turn us back to these rich notes of dedicated field men, most of whom jotted down their notes fired merely by academic curiosity, not by commercial interest? If we do give their writings some consideration, there is always the possibility that, at the moment least expected, we might be led into discoveries of unprecedented potentialities.

Of the numerous narcotic preparations used by witch-doctors in religious, curative and magic rites in South America, Spruce was an early student of two. "Having had the good fortune," he wrote, "to see the two most famous narcotics in use and to obtain specimens of the plants that afford them sufficiently perfect to be determined botanically, I propose to record my observations on them, made on the spot."

From the point of view of modern phytochemistry, however, it is undoubtedly Spruce's pioneer work on the malpighiaceae narcotics of South America that commands prime attention. One hundred and fourteen years have passed since the botanical identification of the principal species involved. In the intervening century, an appreciable amount of botanical and ethnobotanical research has been devoted to these interesting hallucinogens. Notwithstanding this long period of accomplishment, we find it necessary

— even for the proper prosecution of chemical studies today — to study and re-evaluate Spruce's meticulous field observations.

In 1852, during the early stages of his five years of field work on the upper Rio Negro of Brazil and adjacent Colombia and Venezuela, Spruce learned of the use by Tukanoan Indians of the extraordinary drug called *caapi*. It was employed to induce, for prophetic and divinatory purposes, a narcosis characterised, amongst other strange effects, by frighteningly realistic coloured visual hallucinations and a feeling of extreme and reckless bravery. Unlike many of the early reports of similar narcotics, Spruce's contribution included a precise determination of the botanical source of the drug. Finding *caapi* cultivated along the Rio Negro, he noted that "here were about a dozen well growing plants . . . twining up to the tree tops along the margin of a *roça* [a cultivated plot] and several smaller ones. It was fortunately in flower and young fruit; and I saw, not without surprise, that it belonged to the order Malpighiaceae . . ." A collection in full flower (*Spruce 2712*) was taken from the liana used by the natives in preparing the intoxicating *caapi*-drink. Spruce drew up a description of the species from living specimens. He allocated the species to the genus *Banisteria*, calling it *Banisteria Caapi*. This description was then published by the botanist Grisebach. As taxonomic knowledge of the Malpighiaceae became more refined in the present century, the American specialist Morton ascertained that this species-concept could not with precision be included in *Banisteria* and, in 1931, he transferred it to a new but closely allied genus that he characterized and named *Banisteriopsis* (9). The *caapi* liana is, accordingly, now correctly called *Banisteriopsis Caapi* (Spr. ex Griseb.) Morton.

Spruce's observations were recorded in his wonted preciseness in 1852. About 1870, back in England, he wrote an article on the narcotic *caapi* and published it in a very obscure journal. This account was included as a special chapter in Wallace's posthumous account of Spruce's travels

BANISTERIOPSIS *Caapi*

(*Spruce ex Griseb.*) Morton



and work in 1908: "A botanist on the Amazon and Andes". In publishing almost intact Spruce's account, Wallace observed very truthfully that "the whole essay affords a good example of the writer's style and of his power of making even technical details interesting and of introducing bright descriptive flashes and touches of human nature in what might otherwise be a rather dry exposition of botanical and pharmaceutical facts."

Spruce, though a brave and daring explorer, unfortunately was a very sick man. This is probably the explanation of his hesitation fully to experiment personally with caapi — most regrettably so because notes on the effects of the intoxicant from such an analytical mind would have been of extreme value to modern investigators. "I had gone [to a caapi-drinking Indian festival] with the full intention of experimenting the caapi on myself, but I had scarcely dispatched one cup of the nauseous beverage, which is but half a dose, when the ruler of the feast — desirous, apparently, that I should taste all his delicacies at once — came up with a woman bearing a large calabash of *caxiri* (mandioca beer), of which I must needs take a copious draught, and as I know the mode of its preparation, it was gulped down with secret loathing. Scarcely had I accomplished this feat, when a large cigar, 2 feet long and as thick as the wrist, was put lighted into my hand, and etiquette demanded that I should take a few whiffs of it — I who had never in my life smoked a cigar or a pipe of tobacco. Above all this, I must drink a large cup of palm wine, and it will readily be understood that the effect of such a complex dose was a strong inclination to vomit, which was only overcome by lying down in a hammock and drinking a cup of coffee . . ."

In those years, explorers rarely gathered material for phytochemical analysis, and in Spruce's case the great distance and isolation of this scene of field work and the primitiveness and absence of normal communications one might think would have made it impracticable or impossible for him to gather material in bulk for pharmaceutical spe-

cialists. In spite of these drawbacks, however, we know that Spruce did try so to enrich science but, like so many explorers even in modern days, was frustrated in his attempt. "I obtained a good many pieces of stem, dried them carefully, and packed them in a large box, which contained botanical specimens, and dispatched them down the river for England in March 1853. The man who took that box and four others on freight, in a large new boat he had built on the Uaupés, was seized for debt when about half-way down the Rio Negro, and his boat and all its contents confiscated. My boxes were thrown aside in a hut, with only the damp earth for floor, and remained there many months, when my friend Senhor Henrique Antonij of Manáos . . . succeeded in redeeming them and getting them sent on to the port of Pará. When Mr. Bentham came to open them in England, he found the contents somewhat injured by damp and mould, and the sheets of specimens near the bottom of the boxes quite ruined. The bundle of caapi would presumably have quite lost its virtue from the same cause, and I do not know that it was ever analysed chemically; but some portion of it should be in the Kew Museum at this day."

One of the most interesting exercises that I can imagine would be the analysis of a small portion of this original Spruce material — if, indeed, it is still preserved at Kew — with our modern improved chemical techniques. The active principles of caapi (harmine type alkaloids) might not have deteriorated with the mildew, and it is possible that even in this more than a century of storage the alkaloids would be intact.

Proof that, even a century ago, Spruce's thinking was, at least in part, along chemotaxonomical directions may be seen when, upon determining caapi as a new species of Malpighiaceae, he mused: "My surprise arose from the fact that there was no narcotic malpighiad on record, nor indeed any species of that order with strong medicinal properties of any kind. *Byrsonima* — a malpighiaceous genus that abounds in the Amazon Valley — includes many spe-

cies . . . Their bark abounds in tannin and is the usual material for tanning leather at Pará, as also, by the Indians, for dyeing coarse cotton garments a red-brown colour. Another genus — *Bunchosia* — grows chiefly on the slopes of the Andes . . . the seed is described in books as poisonous, and if it be really so, then it is the only instance, so far as I know, of the existence of any hurtful principle in the entire family . . . excepting . . . the caapi.” “Yet,” he prophetically and very correctly remarked, “strong poisons may lurk undiscovered in many others of the order, which is very large and (the twining species especially) of great sameness of aspect; and the closely allied Soapworts (*Sapindaceae*) contain strong narcotic poisons, especially in the genus *Paullinia*.”

The second time that Spruce met with caapi was in June 1854 at an encampment of the wholly uncivilised Guahibo Indians along the Orinoco at the cataracts of Maypures. The Guahibos not only prepared caapi, like their neighbours where Spruce had first seen the drug, as an intoxicating drink, but they “chew the dried stem, as some people do tobacco.” Spruce learned from these roving peoples that “all the native dwellers on the rivers Meta, Vichada, Guaviare, Sipapo and the intervening smaller rivers [in Colombia and Venezuela] possess caapi and use it in precisely the same way.”

Again, in 1859, whilst working in the Ecuadorian Andes, he encountered the Zaparo Indians using a narcotic that they called *ayahuasca*. Spruce wrote that he “again saw caapi planted” in this area and that “it was the identical species of the Uaupés, but under a different name, in the language of the Incas, *aya* — *huasca*, i.e. “dead man’s vine.”

Spruce reported that years earlier, Dr. Manuel Villavicencio had recorded in his *Geografía de la República del Ecuador* that the sundry tribes of the upper Río Napo in Amazonian Ecuador employ *ayahuasca* for sorcery, witchcraft, prophecy and divination. Although apparently no specimens were taken and no reference to botanical identification was made in Villavicencio’s account, that included

a report on self-intoxication, the common name *ayahuasca* was used and the source plant was described as a liana. All later work has shown that ayahuasca in Ecuador and Peru refers to *Banisteriopsis*. Indeed, as Spruce noted, although "of the plant itself," Villavicencio "could tell no more than that it was a liana or vine," his "account of its properties" coincided "wonderfully with what I had previously learnt in Brazil."

All subsequent serious botanical workers on caapi and ayahuasca have substantiated Spruce's very astute judgment — that the two names refer to essentially the same narcotic drink made from *Banisteriopsis*. Recent field work has uncovered the possibility that other species than *Banisteriopsis Caapi* are used: *B. inebrians*, *B. quitense*, *B. Rusbyana*, for example. Still there is not yet agreement amongst modern botanists that these are really distinct species, some taxonomists believing that they are merely synonyms of an unusually variable *Banisteriopsis Caapi*. This justifiable and, at our present state of taxonomic knowledge, truly understandable doubt plagues phytochemists almost as much as the several uncertainties and confusions injected into the picture of the malpighiaceus narcotics by hasty, untrustworthy and widely disseminated writings of so-called "experts" in the recent past. From the phytochemist's point of view, a critical study of Spruce's notes will help rectify much of the confusion that reigns at the present time.

In 1905, a Colombian, Rocha, published an account of his trip to the headwaters of the Ríos Caquetá and Putumayo in Amazonian Colombia, reporting that the natives employed as an hallucinogen a "little bush" or "leaves" called *yajé* (12). His account of the properties of *yajé* coincided strikingly with those described for ayahuasca by many authors, and it was widely assumed that *yajé* and ayahuasca were identical as to the source plant. German, Russian, Colombian and American botanists who have worked in the Colombian Putumayo have all substantiated this viewpoint — with or without voucher specimens. Yet

certain anthropological and pharmaceutical writers, mainly French and none of whom have been in the field, have created a state of confusion almost impossible of disentanglement concerning the source of yajé.

This confusion began when Rouhier (13) suggested that yajé could be an *Aristolochia*, a suggested identification that was accepted by the Colombian chemist Fischer (4). It was, however, the French anthropologist Reinberg (10) who first seems adamantly to have asserted that ayahuasca and yajé might be different plants. Reinberg reported that his assertion that ayahuasca and caapi were conspecific but that yajé could be, with reservations, referred to *Prestonia amazonica*, was based on herbarium material, but, in 1950, I made a search of the Paris herbarium and found there no evidence whatsoever of any material supporting such a novel interpretation.

Since then, numerous French and Belgian writers have fallen into line, accepting Reinberg's "identification" of yajé, even though the Belgian pharmacologists, Michaels and Clinquart (8), obviously more conservative than their French anthropological confrères, dismissed as "doubtful" the possibility that yajé could be referable to *Prestonia amazonica*. Other French writers arrived at even more extraordinarily inexplicable conclusions, but more recently Fabre (3), in reviewing the historical aspects of the identification of ayahuasca, caapi and yajé, concluded that all three are prepared basically from *Banisteriopsis*.

All of these confused reports about *Prestonia amazonica* as a narcotic stem from the way the work of Richard Spruce is interpreted. This confusion has so hindered and atrophied phytochemical research that, in 1950, I decided to consult Spruce's field notes preserved at the Royal Botanic Gardens at Kew in England. Would that all who had written on these drugs had had the meticulous scholarship of Richard Spruce!

When Spruce described caapi as a product of the malpighiaceae *Banisteriopsis* [*Banisteria*] *Caapi*, he stated that there was another kind of caapi in the same region and

14)
 and as I knew the taste of its preparation, ^{was} ~~it would~~
^{could} ~~the~~ ^{small} ~~degree~~ ^{of} ~~leaving~~ ^{scarcely} ~~had~~ ^{accomplish} ~~that~~ ^{purpose}
^{needed} ~~a~~ ^{large} ~~cigar~~ ^{only} ~~2 ft long~~ & as thick as my wrist was put
 lighted into my hand, from which I took a few whiffs.
 — I who never in my life smoked a pipe of tobacco.
 After all this I drank a large cup of palm-wine
 and it may be readily believed that the effect of all this
^{was} ~~to~~ ^{induce} ~~a~~ ^{strong} ~~inclination~~ ^{to vomit}, which
^{was} ~~only~~ ^{overcome} by lying down in a hammock & drinking
 a cup of coffee, which the friend who accompanied me
 had taken the precaution to provide beforehand.

Query? May not the peculiar effect of the Caapi be
 owing rather to the roots of the *Haemadictyon* (though in
 such small quantity) than to the stems of the *Banisteriopsis*?
 The Indians however consider the latter the prime agent,
 at the same time admitting that the former is an
 essential ingredient.

The two plants are planted near all the malocas
 (villages) and not singly? in the mandioca-roças.
 I have never seen any but young stems under a foot
 (mostly) high of the *Haemadictyon*, as the roots of the
 most advanced are continually being taken up for the
 fabrication of Caapi.

At Maypures, on the Orinoco, I again saw Caapi in
 use, by the Guahibo Indians, & obtained from them the
 apparatus used in pulverising it, which I sent to Viceroy
 under no. 177 (See list). This however is more used for
 pulv. seeds of Parich (or Nicot). See p.

Plate 1385. A page from Spruce's field notebook describing the possibility that *Haemadictyon* might be added occasionally to the caapi drink made from *Banisteriopsis* Caapi. Courtesy of the Royal Botanic Gardens, Kew, England.

that it was called *caapi-pinima* or "painted caapi." In his field notebook, preserved at Kew, he wrote: "2712 *Banisteria Caapi* Mss. From this is prepared an intoxicating drink known to all the natives of the Uaupés by the name of caapi. The lower part of the stem, which is the thickness of the thumb swollen at the joints, is the part used. This is beaten in a mortar with the addition of water and a small quantity of the slender roots of the *Apocynac.* (Apparently a *Haemadictyon*) called caapi-pinima or painted caapi, from its leaves being stained and veined with red . . . Query? May not the peculiar effects of the caapi be owing rather to the roots of the *Haemadictyon* (though in such small quantity) than to the stems of the *Banisteria*? The Indians, however, consider the latter the prime agent, at the same time admitting that the former is an essential ingredient. The two plants are planted near all mallocas (villages) . . ."

When these notes were published in 1908, they suffered a slight, but significant, change of emphasis. The terms of qualification disappeared. The published version states that caapi-pinima "is an apocynaceous twiner of the genus *Haemadictyon*, of which I saw only young shoots, without any flowers. The leaves are of a shining green, painted with the strong blood-red veins. It is possibly the same species . . . distributed by Mr. Bentham under the name *Haemadictyon amazonicum* n.sp. It may be the caapi-pinima which gives its nauseous taste to the caapi . . . and it is probably poisonous, . . . but it is not essential to the narcotic effect of the *Banisteria*, which (so far as I could make out) is used without any admixture by the Guahibos, Zaparos and other nations out of the Uaupés."

Spruce was one of South America's most meticulous of scientific observers. A less careful and botanically untrained observer might easily have confounded the young shoots of *Haemadictyon amazonicum* (now correctly called *Prestonia amazonica*) with *Banisteriopsis*, for the leaves of both are opposite, and the leaves of some species of *Prestonia* do resemble remarkably those of *Banisteriopsis* in shape and texture. But Spruce could never have confused

an apocynaceous plant, full of a white latex, with a *Banisteriopsis*. He might have erred as to genus, for the genera of the Apocynaceae are often hard to distinguish even with flowers. But even this possibility would seem, in the case of Spruce, to be remote. In my own many years of exploration in the Rio Negro basin of Colombia and Brazil, I followed along Spruce's itinerary in great part and searched especially for an apocynaceous vine growing around Indian huts, as described by Spruce: although every Indian *Manihot*-plot boasts its several cultivated vines of *Banisteriopsis*, nothing resembling a *Prestonia* was ever seen under cultivation.

A careful reading of Spruce's notes reveals that he never claimed more for *Prestonia* or caapi-pinima than the role of an admixture. We know from reports of later investigators that other plants are sometimes added in small amounts to the beverage prepared from *Banisteriopsis*, in the belief that they change or fortify the effects of the narcotic drink. For example, I (18) reported the admixture of leaves of an apocynaceous tree — possibly *Malouetia Tamaquarina* — by the Makunas of the Río Popeyacá of Colombia. Later writers, without supporting herbarium specimens and taking their cue from Spruce whose notes and files they misread or misunderstood, now propose that the narcotic drink in one part of the Amazon, where it is known as yajé, is prepared exclusively from *Prestonia amazonica*. For this assertion, there is absolutely no basis in field work.

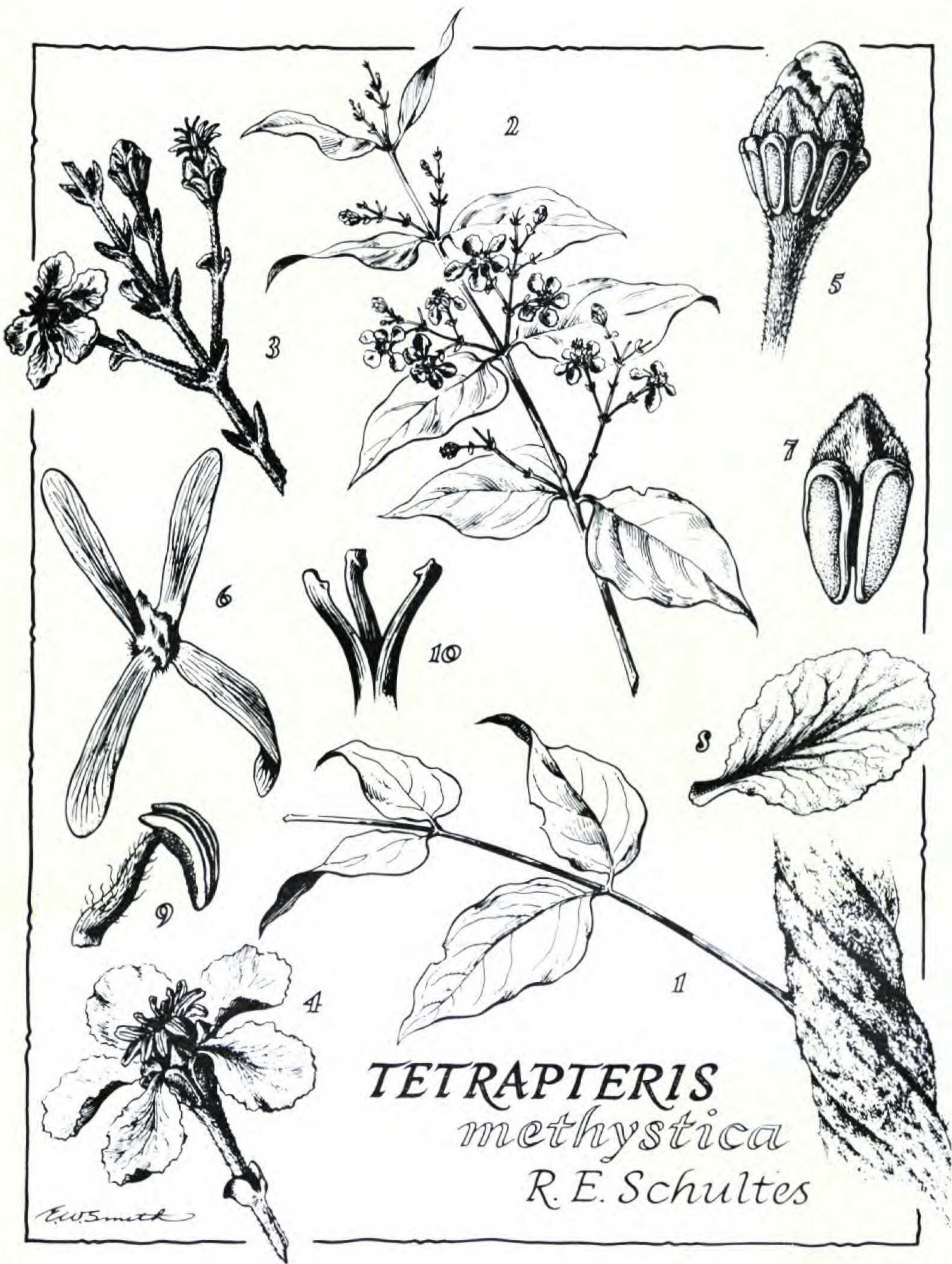
Prestonia amazonica is known, furthermore, from only one collection — the type collection made by Spruce in 1859 at Trombetas on the lower Amazon. In more than a century, the species has never been found again. We are forced to conclude, consequently, that *Prestonia amazonica* is either a very rare species or else a strict endemic, confined to the general region of the type collection. The Rio Trombetas lies more than 1200 miles in a straight line from the eastern slopes of the Andes of Colombia, where we are expected to believe that the natives are using this rare species in rela-

tive abundance as the source of their frequently employed yajé.

The chances that *Prestonia amazonica* is used are, for all practical purposes, non-existent; and there seems to be no evidence that any species of *Prestonia* is so employed along the eastern slopes of the Andes of Colombia and Ecuador — or indeed in the entire Amazon. Even in the area where Spruce reported its possible use a hundred years ago, there is all probability that, if employed at all, it was utilized solely as an admixture with *Banisteriopsis*. Nevertheless, modern phytochemistry would do well to investigate this reportedly poisonous apocynaceous genus of some 30 species of tropical America. Little is known of *Prestonia* chemically, and the recently published analysis of *P. amazonica*, in which the presence of N — N dimethyltryptamine was reported, was undoubtedly based on a misidentified infusion made from *Banisteriopsis Caapi* (22).**

Spruce reported that the Indians of the Rio Uaupés distinguished two kinds of caapi, the minor one called *caapi-pinima*. Much later, Koch-Grünberg (7) found that the Tukanos of the Uaupés know two kinds, but he could identify botanically only one: *Banisteriopsis Caapi*. In 1948, one hundred years after Spruce, I discovered the Indians on the Rio Tikié, a Brazilian affluent of the Uaupés, preparing an intoxicating drink from the malpighiaceus genus

**Very recently, one of my graduate students, Mr. Homer V. Pinkley, learned that the Kofán Indians of Amazonian Ecuador sometimes add the leaves of *Banisteriopsis Rusbyana* to the drink prepared from the bark of *B. Caapi* or *B. inebrians* to "fortify" it. Holmstedt (in litt.) informs me that an analysis of these leaves collected by Pinkley indicates that the species contains harman alkaloids and N, N-dimethyltryptamine. *Banisteriopsis Rusbyana* is called *óco-yaje* by the Kofán; *B. Caapi* and *B. inebrians* are known simply as *yaje*, as is the narcotic drink. One is led to wonder, in view of this recent discovery, whether or not the admixture so often stated to be *Prestonia amazonica*, from which the tryptamine was erroneously reported, is, in reality, *Banisteriopsis Rusbyana*. The material analysed by Holmstedt has been identified against a voucher collection: *Pinkley 449*, deposited in the Economic Herbarium of Oakes Ames in the Botanical Museum of Harvard University. (R. E. S. July, 1968).



TETRAPTERIS
methystica
R. E. Schultes

Tetrapteris: from a species called *T. methystica* (16). From the bark of this gigantic forest liana, with no admixtures, a bitter beverage is prepared. I experimentally learned that it had strong hallucinogenic properties. The drink was rather yellowish, unlike the usual chocolate-brown of the drink prepared from *Banisteriopsis Caapi*. One wonders whether or not the term "painted caapi" reported by Spruce could have referred to the kind of caapi that makes this unusual yellowish drink.

The confusion resulting from the misinterpretation, misrepresentation and misunderstanding of Spruce's very obvious suggestions concerning *Prestonia* as a possible narcotic are, unfortunately, typical of so much that plagues modern phytochemistry and that will continue to do so, until more thorough botanical evidence is demanded by non-botanical writers before categorical statements are made either on carefully qualified suggestions or without voucher specimens.

A century of research work, from Spruce's time to the present, has given us an appreciable body of information about ayahuasca, caapi and yajé, but much still remains to clarify and much still remains to discover. There are numerous problems demanding research, problems not even touched upon by Spruce. One of these concerns the use of admixtures with *Banisteriopsis* and the identity of the plants employed as admixtures. Another concerns different "kinds" of basic plants employed. This problem has been reviewed recently in the literature (5, 18). Most recently, a Brazilian anthropologist, Alves da Silva (1) has indicated, through aboriginal names, the use of five presumably different lianas and several admixtures in the preparation of caapi by the Tukanos in the very region where Spruce's work was done one hundred years ago.

The second hallucinogen that Spruce encountered and studied assiduously in the field was the *yopo* or *niopo* snuff of the upper Orinoco of Colombia and Venezuela.

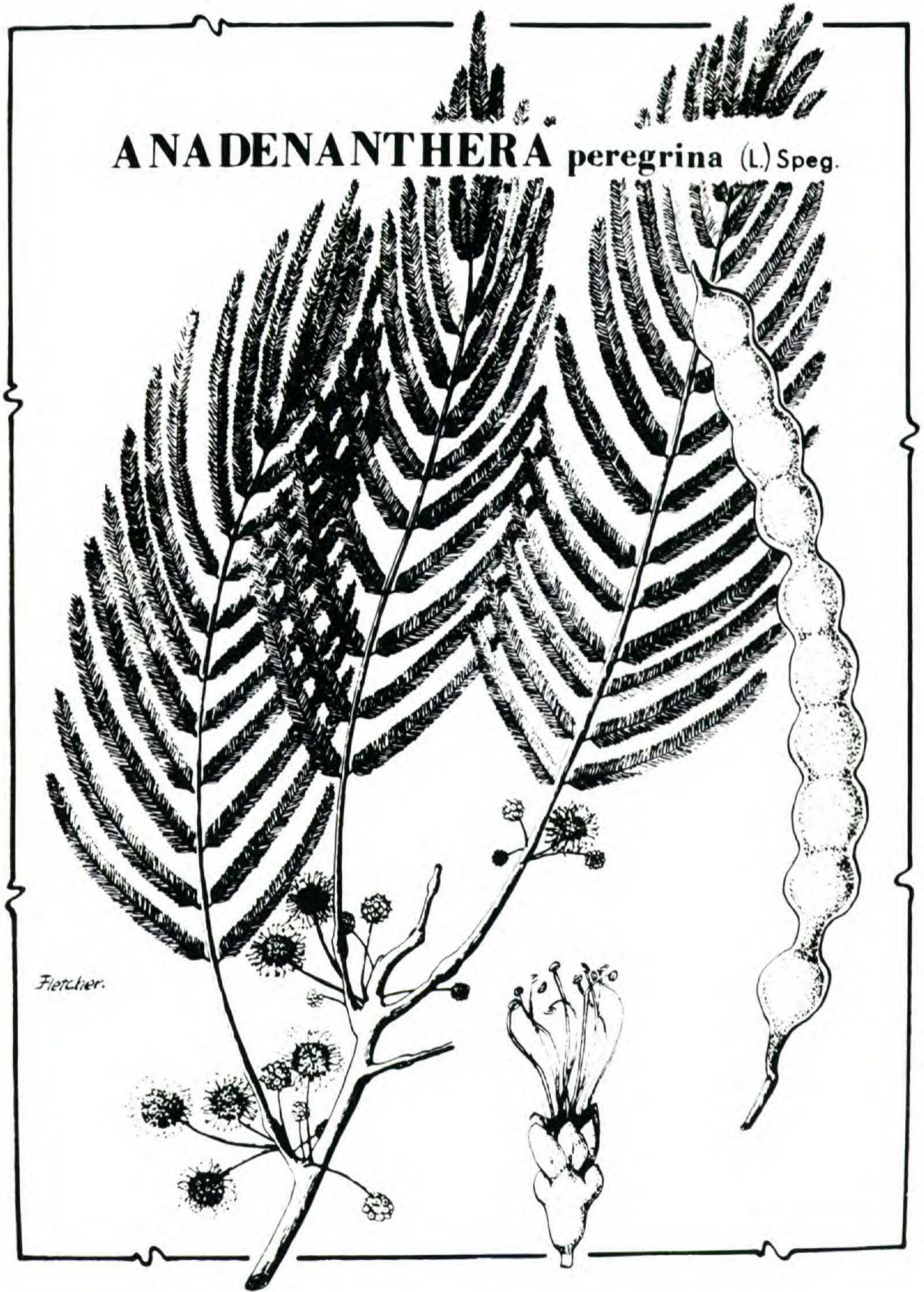
It was Humboldt's expedition that first identified the source plant as a species of the leguminous genus *Pipta-*

denia in 1801 (6). There is a very brief account of its narcotic use: "Ex seminibus tritis calci vivae admixtis fit tabacum nobile que Indi Otomacos et Guajibos utuntur." The plant was first described by Humboldt as a species possibly of *Acacia*: then it was transferred to the genus *Inga*; finally, it was accommodated in *Piptadenia* as *P. Niopo*.

Spruce collected material of the plant (*Spruce 1786*) along the Rio Janauarí. Bentham determined it as Linnaeus' *Mimosa peregrina* but placed it in the genus *Piptadenia*, thus altering its name to *P. peregrina*. This is the name by which the source of yopo snuff has been known until recently, when modern taxonomic studies have tended to show that the plant may belong to the genus *Anadenanthera*, in which case the modern name should be *A. peregrina* (11).

We owe to Spruce the earliest reliable ethnobotanical studies on yopo, although I strongly suspect that some of the present confusion surrounding the use of this snuff may trace back to his writings.

It will be necessary here to diverge for a moment from Spruce's work and consider briefly the state of our knowledge concerning South American narcotic snuffs. Most snuffs used by natives in South America are conveniently identified as being made either from tobacco or from *Piptadenia*. Cooper's distribution map, for example, indicates that *Anadenanthera peregrina* snuff is taken in most of the western Amazon and in many other isolated spots through the Amazon Valley (2). That Cooper himself recognised the unsatisfactory status of our knowledge is evident from his remarks that "some of the attributions may not be correct, since, in some cases, the lack of exact botanical identification makes it doubtful whether we have to do with *Piptadenia* snuff, tobacco snuff or snuff from some other plant . . ." We have now come to suspect (21, 24) that the snuffs used in the Amazon Valley itself are rarely if ever made from this species. In fact, it is now clear that *Anadenanthera peregrina* is a rare plant in the Amazon, where it occurs, for the most part, along the upper Rio



Branco or elsewhere rarely. In my long period of botanical exploration in the Amazon, including a number of years in Spruce's territory of the upper Rio Negro basin, I never once met with *Anadenanthera peregrina*, although, as a specialist on native narcotics, I kept a sharp outlook for it. Eight other species referred to *Piptadenia* are known to occur in the Amazon, and I suspect that, in the field, Spruce attributed some of these — not known to have narcotic properties — to his concept of *P. peregrina*. He said “. . . I have traced the tree all the way from the Amazon to the Orinoco, . . . although it bears a different name on the two rivers . . .” The species apparently does not have this distribution now.

Recent ethnobotanical work has uncovered other plants as the sources of psychotomimetic snuffs. One of the most interesting, used in the northwesternmost part of the Amazon, in the upper Rio Negro basin, and adjacent areas of the uppermost Río Orinoco and its tributaries, is prepared from the red resin of the bark of certain species of the myristicaceous genus of *Virola*, especially *V. calophylla* and *V. calophylloidea* (17). I suspect that a species of the acanthaceous genus *Justicia* may be used in the preparation of a snuff of the Waiká Indians of the headwaters of the Orinoco.*** In the central part of the Brazilian Amazon, a psychotomimetic snuff, said to be prepared from the fruits of a jungle tree of the Moraceae, *Olmedioperebea sclerophylla*, has recently been found (20). Other snuffs, as yet unidentified, are known from several localities in South America.

In view of the brevity of Humboldt's report of the preparation of yopo snuff, Spruce's detailed notes acquire much more importance to ethnobotany and phytochemistry. “I did not see the snuff actually prepared from the seeds and

***Very recent investigation has shown that the snuff of the Waiká Indians is prepared basically from *Virola theiodora*, sometimes with the admixture of pulverized leaves of *Justicia pectoralis* var. *sphenophylla* and ashes of the bark of *Elizabetha princeps*. This report was published in *Rhodora* 70 (1968) 113-160. (R. E. S. July, 1968).

in use until June, 1854, at the cataracts of the Orinoco. A wandering horde of Guahibo Indians, from the river Meta of Colombia, was encamped on the savannahs of Maypures and on a visit to their camp, I saw an old man grinding niopo seeds, and purchased of him his apparatus for making and taking the snuff . . .

“The snuff is kept in a mull made of a bit of the legbone of the jaguar, closed at one end with pitch and at the other end stopped with a cork of marima bark. It hangs around the neck . . .

“The Guahibo had a box of caapi hung from his neck, along with the snuff-box, and as he ground his niopo he every now and then tore off a strip of caapi with his teeth and chewed it with evident satisfaction. ‘With a chew of caapi and a pinch of niopo,’ said he, in his broken Spanish, ‘one feels so good! No hunger — no thirst — no tired!’ From the same man, I learnt that caapi and niopo were used by all the nations on the upper tributaries of the Orinoco. . . .”

Much research — ethnobotanical, botanical, phytochemical and pharmacological — has been devoted to yopo snuff. It was probably Spruce’s writings more than those of any other investigator, however, that have spurred this research on over the past century.

One of the interesting characteristics about Spruce’s writings is that I have never been able completely to understand the paucity of incidental notes on plants with physiological activity. Such long residence amongst the natives of the Amazon might be expected to have enabled Spruce to see so much more that he could report concerning medicinal plants, fish poisons, arrow poisons and other plants of medicinal notice. It may be that Spruce kept such observations in a separate notebook that has been lost, but it is rather more probable that he never dreamed of following up seriously any of these aboriginal uses and, therefore, failed to jot more of them down.

In the two volumes *Notes of a botanist on the Amazon and Andes*, I find no references to any of the arrow or dart

poisons. Nor do I see any mention of plants referred to as fish poison, although this aspect of Indian culture could not have escaped an explorer who lived so long amongst the natives. Furthermore, even though some of the tribes of the upper Rio Negro and Uaupés are known as makers of the most powerful curare preparations or arrow poisons, Spruce is strangely silent on this point. A study of the botanical material amassed on his trips indicates that Spruce did, in fact, collect many of the plants employed in the region as fish poisons or in making curare, but they usually bear no notes regarding these uses. How Spruce, for example, could have failed to discover the use of *Virola* in snuff-making in the uppermost Rio Negro I can never explain, especially when he described as new a number of myristicaceous species.

My own botanical explorations in the northwest Amazon from 1941 through 1953 enabled me to re-trace, in part, Spruce's itinerary. Many are the notes on toxic or medicinal uses that the natives have for plants that Spruce himself collected for the first time and introduced to science with not a note. A few examples will indicate why I am puzzled in this regard.

Spruce collected several species of the genera *Connarus* and *Rourea* in the Rio Negro basin. The roots and stems of these vines are pounded and employed as fish-poisons. Nothing, apparently, is known phytochemically of these uses, nor did Spruce mention them. Spruce collected the type of *Caryocar gracile* (Spruce 2550) of the Caryocaraceae at Ipanoré on the Rio Uaupés. In this region today the leaves of *Caryocar gracile* and other species of the genus are crushed and made into a paste that is administered to dogs for the purpose of killing them when they have once fled with fear in the hunt. Another member of the same family collected by Spruce (Spruce 2146) at San Carlos, Venezuela, is *Anthodiscus obovatus*, said to be an ingredient of curare, along with *Strychnos*. Spruce failed to report these relatively important uses of *Caryocar* and *Anthodiscus*. The root of the rubiaceous genus *Duroia* —

especially *D. petiolaris* collected by Spruce — is reputedly toxic. Another genus of this family, *Retiniphyllum*, has the reputation of possessing a toxic resinous exudation from the inflorescence. Spruce collected three species of *Retiniphyllum* in the upper Rio Negro basin — *R. truncatum*, *R. concolor* and *R. speciosum*, all of which are reputedly poisonous, although *R. truncatum* has the reputation of being the strongest. He apparently did not mention the interesting and widespread native belief that the bones of the bird pajuíl (*Nothocrax urumutum*) are toxic to dogs if the bird has eaten the ripened fruit of the apocynaceous tree *Malouetia* (19).

There is, however, so much of value for phytochemistry to be gleaned from Spruce and other contemporary explorers that we should not dwell with too much severity on such minor shortcomings — if, indeed, shortcomings they be. We should here decide to utilise efficiently what they leave us.

We cannot but admire a man like Spruce who, in spite of oppressive sickness, weariness and frustration, was encouraged and spurred on to incredible feats by a dynamic love of knowledge for the sake of knowledge. In a letter to Mr. George Bentham he wrote in part: “I have lately been calculating the number of species that yet remain to be discovered in the great Amazonian forest, from the cataracts of the Orinoco to the mountains of Matto Grosso; taking the fact that by moving away a degree of latitude or longitude I found about half the plants different as a basis, and considering what very narrow strips have, up to this day, been actually explored, and that often very inadequately, by Humboldt, Martius and myself, and others, there should still remain some 50,000 or even 80,000 species undiscovered. To anyone but me and yourself this estimation will appear most extravagant, for even Martius (if I recollect rightly) emits an opinion that the forests of the Amazon contain but few specimens . . .

“At the highest point I reached on the Uaupés, the Jaguaraté Caxoeira, now the boundary line between Brazil and

Colombia, I spent about a fortnight, in the midst of heavy rains, when (according to my constant experience) very few forest trees open their flowers. But when the time came for my return to Panuré the weather cleared up, and as we shot down among the rocks which there obstruct the course of the river, on a sunny morning, I well recollect how the banks of the river had become clad with flowers, at it were by some sudden magic, and how I said to myself, as I scanned the lofty trees with wistful and disappointed eyes, 'there goes a new *Dipteryx* — there goes a new *Qualea* — there goes a new the Lord knows what! until I could no longer bear the sight and covering up my face with my hands, I resigned myself to the sorrowful reflection that I must leave all these fine things 'to waste their sweetness on the desert air.' From that point upwards, one may safely assume that nearly everything was new, and I have no doubt that the tract of country lying eastward from Pasto to Popayán where are the head-waters of the Japuré, Uaupés, and Guaviare — . . . offer as rich a field for a botanist as any in South America. But I have made enquiries as to the possibility of reaching it, and I find that it will be necessary to cross páramos of the most rugged and inhospitable character, and afterwards risk oneself among wild and fierce Indians, so that I fear its exploration must be left to some one younger and more vigorous than myself."

It is in great part from men like Spruce, that we may continue to expect — even in this commercialised day of high pressure and efficiency — progress in our study of the numberless unknown chemical compounds resident in the vegetation of the world.

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